Hydraulic and Hydrologic
Considerations in Planning

RISK & UNCERTAINTY
&
LEVEE CERTIFICATION POLICIES

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Objectives

- **Review the Risk & Uncertainty Policies of the Corps.**
- **Review Recent & Current Levee Certification/Safety Evaluation Policies of the Corps.**
- **Identify the H&H engineer's role for Risk & Uncertainty analysis and for Levee Certifications/Safety Evaluations**

Risk & Uncertainty Analysis

- **References:**
  - **ER1105-2-100, Planning Guidance Notebook, 22 April 2000**
  - **ER 1105-2-101, Risk Analysis for Flood Damage Reduction Studies, 3 Jan 2006**
  - **EM 1110-2-1619, Risk-Based Analysis for Flood Damage Reduction Studies, 1 Aug 1996**

- **USACE Publications:**
  http://140.194.76.129/publications/

Risk & Uncertainty Analysis

- **“Planners shall identify areas of risk and uncertainty in their analysis and describe them clearly, so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of alternative plans.” – ER 1105-2-100**

Traditional Expected Annual Damages (EAD) Analysis

EM 1110-2-1619
1 Aug 96

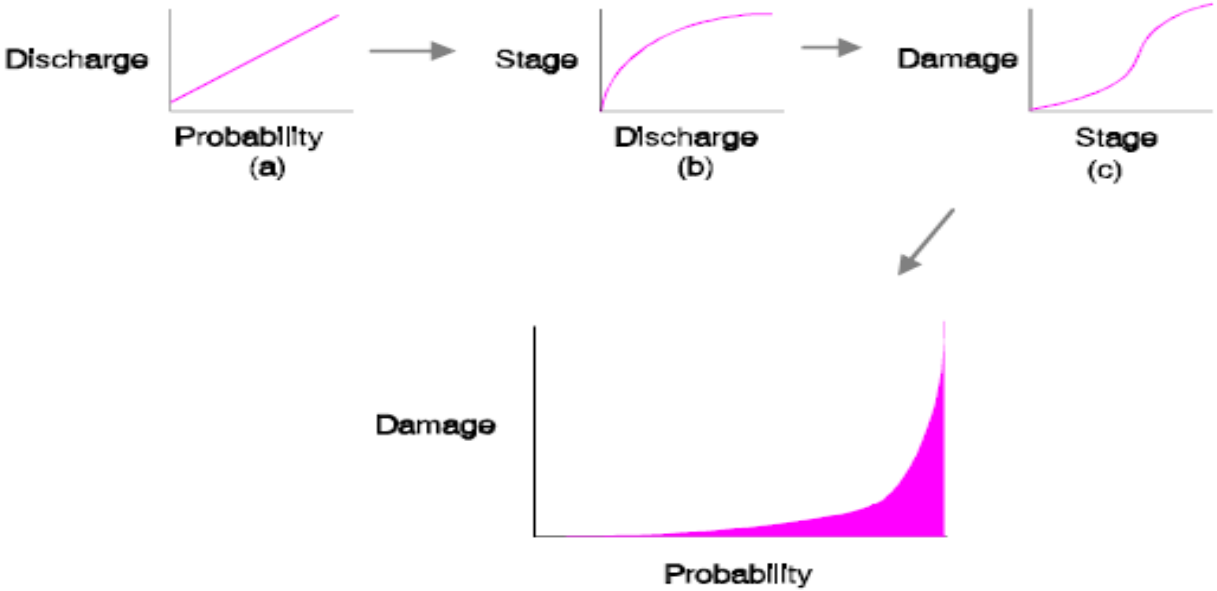

Figure 2-1. Illustration of transformation for traditional expected annual damage computation

Factors Containing Uncertainty

- **Discharge-Frequency (Probability)**
  - Discharge measurements
  - Length of Historical Records
  - Hydrologic Modifications to watershed (land use changes, urbanization, reservoirs, channel modifications, etc.)
- **Stage-Discharge**
  - Stage and Discharge measurements (variability, loop-effect)
  - Regression techniques (if stage and discharge not available)
  - Cross-section measurements
  - Channel variability (sedimentation, channel roughness)
  - Seasonal changes (vegetation, water temperature)
- **Stage-Damage Functions**
  - Identifying structure numbers and elevations
  - Real estate appraisal valuations
  - Determination of depth-damage functions
  - Content depth-damage functions

Discharge-Frequency Data

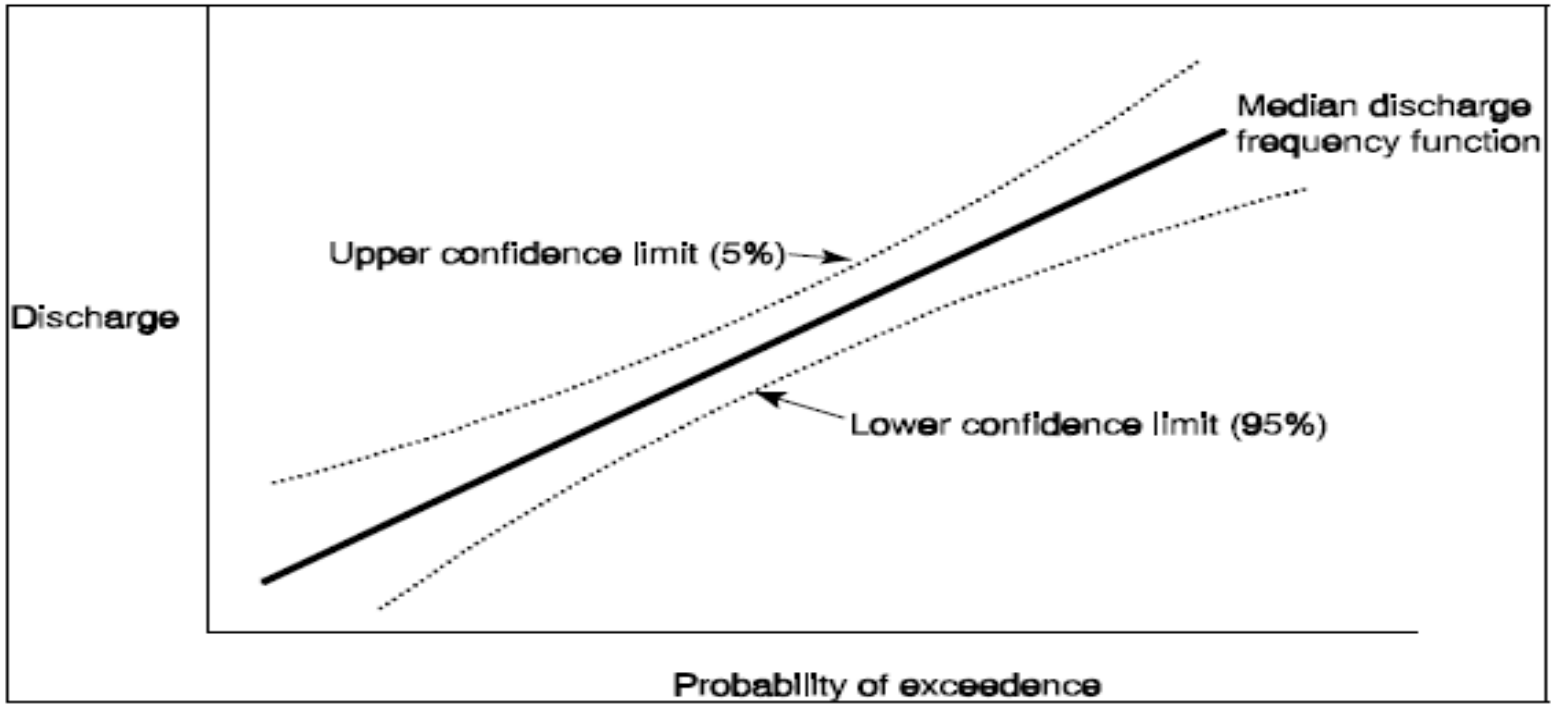

Figure 4-1. Confidence limits

From the available data record, the Confidence Limits are drawn to contain 90% of events. Generally, a longer data set results in more confidence in estimating discharge-frequency and the confidence limits will become narrower. There will still always be some uncertainty, however.

Risk & Uncertainty Analysis

- **Under Current Guidance, For Levees and Floodwalls:**
  - **H&H Studies and Designs must use Risk Analysis**
  - **Geotech and Structural Analysis continues to apply traditional deterministic analysis**

Risk & Uncertainty Analysis for Studies

- **From ER 1105-2-101, Risk Analysis for Flood Damage Reduction Studies, 3 Jan 2006 -- At a minimum, Risk Analysis for studies must incorporate the following variables:**
  - **Stage-Damage function for economic studies (special emphasis on structure 1st floor elevations, depth-percent damage relationships, & content & structure values for urban areas)**
  - **Discharge associated with exceedance frequency for hydrologic studies**
  - **Conveyance roughness & cross-section geometry for hydraulic studies**
  - **Structural & geotechnical performance of existing structures (levees, dams, etc.) – currently applied through Probable and Non-Probable Failure Points**

Risk & Uncertainty Analysis Outputs for Flood Risk Management Studies

- From ER 1105-2-100, FRM studies will provide:
  - Estimate of NED (Net Economic Development) Benefits & Benefit/Cost Ratio for each alternative
    - Include probability that Net Benefits are positive
    - Probability that B/C Ratio is at or above 1.0
  - Expected Flood Risk Management Performance to include:
    - Annual Exceedance Probability with associated estimates of uncertainty
    - Equivalent long-term risk of exceedance over 10-, 30-, and 50-years
    - Ability to contain specific historic floods
  - Residual Risk - Expected annual probability of each alternative being exceeded.

Risk & Uncertainty Analysis Outputs for Flood Risk Management Studies

- **Special Guidance from ER 1105-2-100, for FRM studies:**
  - **Use of Freeboard to account for uncertainty is no longer to be used in levee planning and design**
  - **Certification of levees must follow current guidelines in FEMA/USACE memorandum on Levee Certification for the National Flood Insurance Program**
  - **Project performance will be described by annual exceedance probability and long-term risk rather than level-of-protection**
  - **Analysis to assure safe, predictable performance of the project will be included, including managing capacity exceedance.**

Risk & Uncertainty Analysis

- **H&H Role in Risk & Uncertainty in Flood Risk Management Studies**
  - **Develop the Stage-Discharge Relationships within the Study Watershed**
  - **Develop the Discharge-Frequency Relationships within the Study Watershed**
  - **Estimate the ranges of key uncertainty factors and analyze their impacts (sensitivity) to the stage-discharge and discharge-frequency relationships**

Levee Safety Program
Levee System Evaluation

Levee System Evaluation

- **References:**
  - EC 1110-2-6067, Engineering and Design: USACE Process for the National Flood Insurance Program (NFIP) Levee System Evaluation, 31 Aug 2010
  - Director of Civil Works Memorandum “Guidance on Levee Certification for the National Flood Insurance Program – FEMA Map Modernization Program Issues, 23 June 2006
  - FEMA, “Procedural Memorandum 34 – Interim Guidance for Studies Including Levees,” 22 Aug 2005
  - 44 Code of Federal Regulations Chapter 1, Subchapter B, Part 65
  - ER 1105-2-101, Risk Analysis for Flood Damage Reduction Studies, 3 Jan 2006
  - Director of Civil Works Memorandum “Guidance on Levee Certification for the National Flood Insurance Program,” 10 Apr 1997
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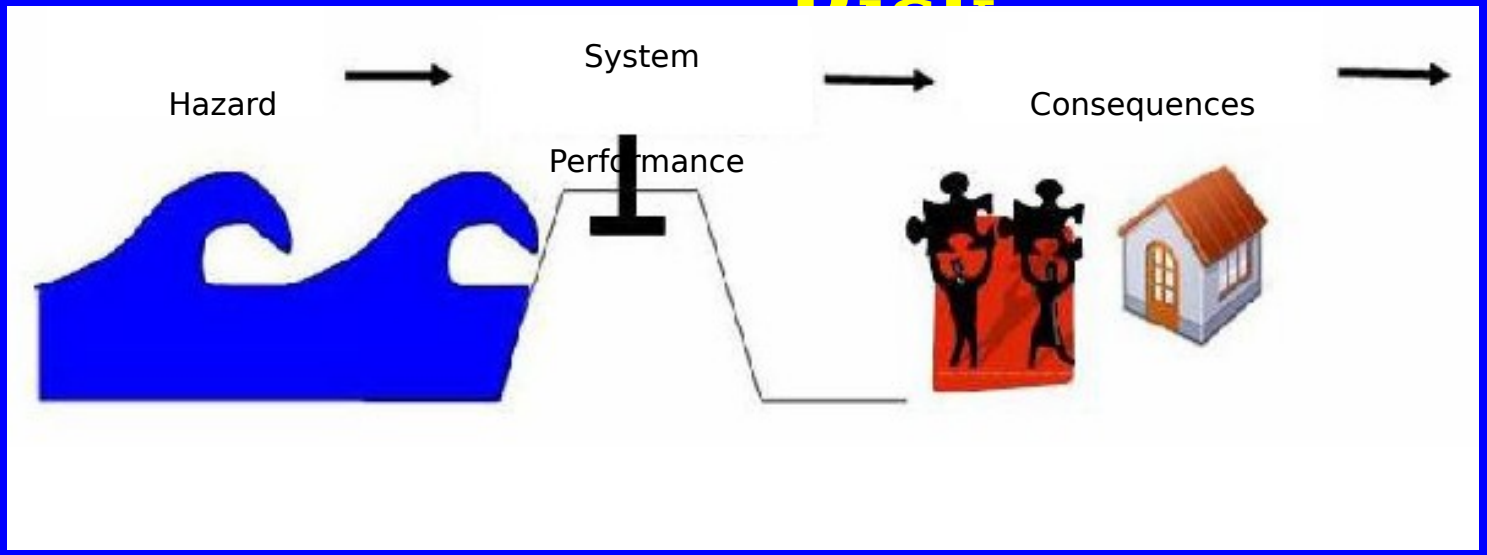
EC 1110-2-6067

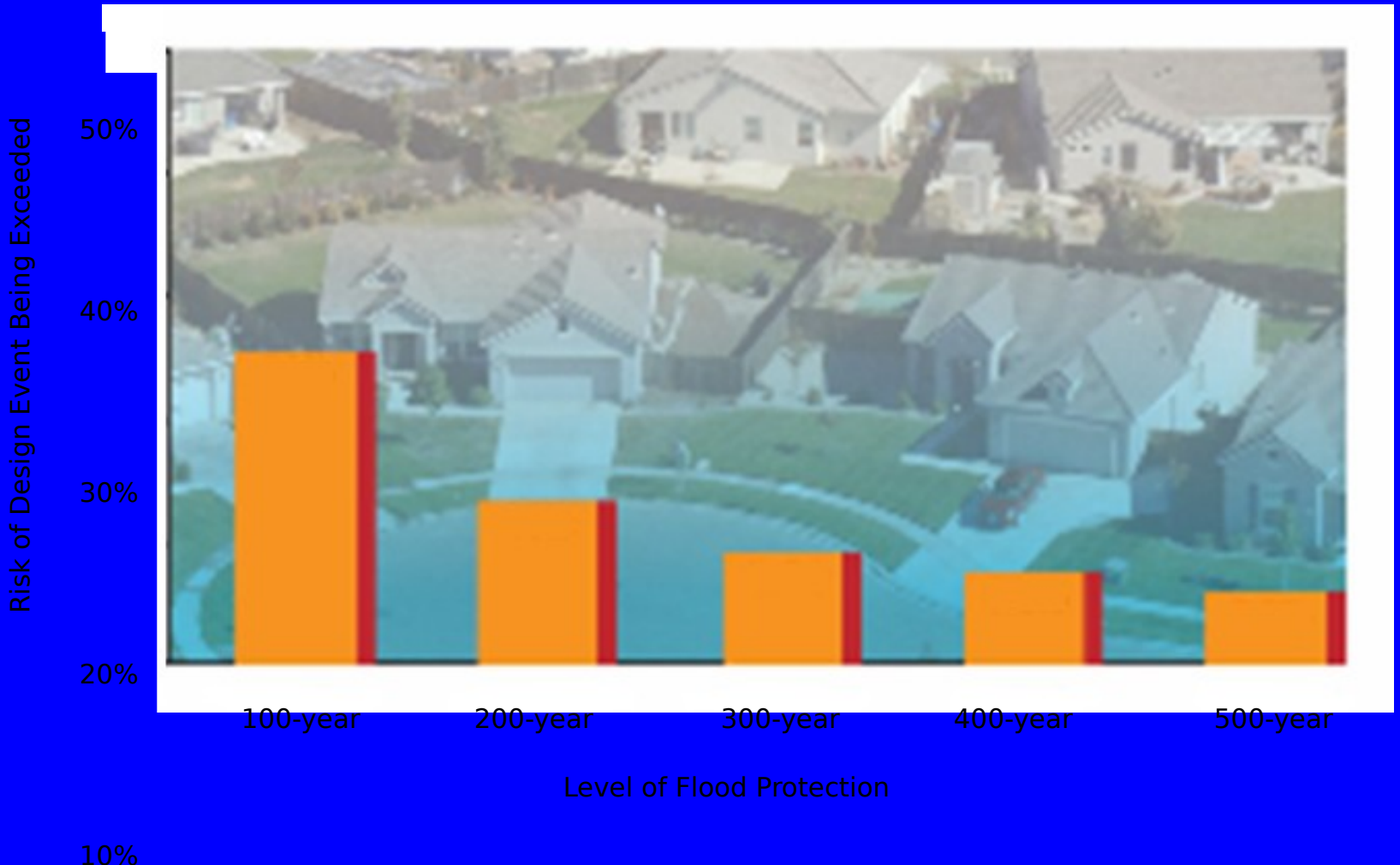
- **Title - *USACE Process for the National Flood Insurance Program (NFIP) Levee System Evaluation***
- **Supersedes all previous guidance –**
  - **April 1997, June 1997, June 2006, August 2006, draft ETL 570 Sept 2007**
- **All ITR comments were addressed.**
- **Currently being routed at HQ for final signature.**

Risk

- **Act now to address all facets of Risk**



Quantifying Residual Risk



Levee Safety Program Message

- **Public safety is our top priority**
- **Levees do not completely eliminate flood risk**
- **It’s a shared responsibility**
- **The 1% event is not a safety standard**

Not a Safety Standard

- **The 1% Event (100-year) is NOT a Safety Standard**
- **Intended for flood insurance**
- **Unintentionally encouraged communities to seek this level**

Why it’s a local responsibility

- **Local communities must legally adopt the FIRM and administer NFIP requirements.**
- **Local communities/residents make decisions about flood insurance and development.**
- **Local sponsor operates and maintains the levee systems.**
- **Certification/Levee System Evaluation is not a one-time requirement; therefore, is considered part of O&M.**

Why USACE focuses on Levee Safety Program

- **Focus on levees on all sizes.**
- **Focus on all potential failure modes.**
- **Focus on the worst first.**
- **Consider potential consequences.**
- **Conduct assessments to determine if levees will perform as designed.**
- **Focus risk communication.**

USACE's Role

- **If requested by a local sponsor, USACE may budget for and perform a certification for systems we O&M or have major maintenance responsibilities.**

- **If requested by a local sponsor, USACE may certify a levee system as part of a current project.**

- **Levee Safety Program activities can support local's certification efforts.**

65.10 vs. EC

FEMA 44CFR65.10

- **3’ Freeboard**
- **“Certifies” design and construction**
- **Components can be submitted separately**
- **Applies to everyone**
- **No validity period**
- **Does not address residual risk**
- **Does not evaluate performance**

USACE EC

- **Probabilistic method**
- **Evaluates entire system, all components and features**
- **No partial certifications**
- **Only applies to USACE evaluations**
- **10 year validity period**
- **Addresses residual risk and public safety**
- **Evaluates performance**

H&H Role in Levee Safety Evaluations

- **H&H Analysis to Determine the 1% Stages/Profile for a Levee System**
  - **Modeling to compute 1% flows, stages & profiles**
  - **Risk & Uncertainty analysis**
  - **When necessary, interior stages for floodplain mapping**

- **Provide H&H analyses/data for the PDT to accomplish:**
  - **Geotech – Analysis to determine seepage risks during floods**
  - **Structural – Head differentials for Levees & Floodwalls during floods**

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Questions?